Agugust 1998 Volume 9 Number 3

ON LICENSING AND A FEW OTHER THINGS

Licensing renewal season is upon us. We have already sent out renewal notices for refrigeration; sometime in August we will send out renewals for Steam. We have already got many phone calls from confused customers, and I will try to clarify a few things.

Refresher courses are required ***only for steam licenses*** and ***not for refrigeration.*** Since we are using essentially the same renewal form, you have to read carefully what the form says. However, if you have a ***refrigeration license*** you do not have to worry, ***there is no refresher course***.

If on the other hand you chose the hard way out and have a steam license (just kidding to see how many were awake), your application will have a date before which the refresher course must be taken.

For some of you, the date will be 9/30/99, for others it will be 9/30/2000, etc., up to 9/30/2003.

For those whose date is 9/30/99, their license will be renewed upon payment of the renewal fee. However, they will have until 9/30/99 to submit proof that they have taken and passed the refresher course. If they do not, their license will not be renewed after 9/30/1999.

This is the procedure we have envisioned. If for some reason you have a **steam license** and you do not see a date on your next renewal, well, give us a call.

Now, knowing human nature, I know that some of you will wait until September 29 before acting, and that is not going to work because the schools will be so busy that you will be turned away, and you will end up jeopardizing your license.

As of this writing, there are five schools which have been approved to administer refresher courses. There is no other alternative path toward fulfilling the refresher course requirement. The schools are:

Renton Technical College (425) 235-2352
Lake Washington Technical College (425) 739-8100
Bates Technical College (253) 596-1723
Georgetown Power Plant Museum (206) 763-2542
Box Plant Training Systems (206) 444-9975

Some schools may be more prepared and ready than others to administer the course. I suggest that you give them a call to find out the details of the course. ***See Page 6 for additional comments on licensing***

(Giovanni Ranieri)

No Gas, No Boom

(by David F. Plantier, Boiler & Combustion Seminars)

Safe Boiler Troubleshooting Requires Looking at the Big Picture

In a recent workshop on boiler room operation and maintenance, the topic of safety came up. The group tried to generate language to help people practice better safety techniques in the boiler room. They finally devised a simple answer: “No gas, no boom.” (“No oil, no boom” also works.)

This slogan is not meant to simplify the situation. Many mechanics believe they need the presence of the main fuel to check the system. This assumption is not true. Except for determining how well the main fuel lights off and adjusting the fuel-air ratio, the mechanic can check the entire system for safety without the main fuel present.

Troubleshooting requires the mechanic to take a problem apart and expand his thought process to include all the elements involved.. For example, turn off the downstream gas cock. Start the burner. What happens? Yes, the burner shuts down, but more is happening.

The blower motor starts, therefore the three-phase power, the motor starter, and the beginning cycle of the flame safeguard are all working. The dampers then open for pre-purge. Thus, the modulating motor works, the linkage is not jammed, and if the purge timer continues, the high fire or purge interlock is working.

After the pre-purge timing is completed, the modulation system drives the dampers to the low fire position and the low fire start switch activates. If the low fire start switch does not activate, the flame safeguard sequence stops just before the trial for ignition (pilot) period; the blower runs until the condition is corrected.

After the low fire start switch does activate, a 10 second trial for ignition (pilot) starts powering the pilot valve and the ignition transformer. When the flame relay is energized, it signals that an adequate pilot has been proved and that the scanner and the flame amplifier work. At the end of the 10 seconds, with a pilot still proved, the main fuel valves are energized for a 10 second period called “trial for main flame trial.” The automatic gas valves should open, but the downstream gas cock is off.

Ten seconds after the main valves start opening, the pilot shuts off. About three or four seconds later the main valves close, and the control locks out on flame failure. The safety devices of the flame safeguard work because they have shut down the system properly.

During this procedure several other interlocks or switches also are proved, including an airflow switch, fuel pressure switches, and, possibly a proof closure interlock. With all the components that have been checked on this boiler control system, the main fuel is still off.

Each situation has a different list of safety controls. The challenge is to figure out which controls are on each installation.

How do you practice “no gas, no boom”? The next time you are ready to start a boiler, run through one cycle with the main gas off and check all the safety controls first. If there is a problem, you will observe it and fix it without any danger to yourself or your equipment.

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see letter on Page 9

Pick-up Factor (by George Folta)

The Chief inspector looked up and saw Inspector Glutz standing at his door.

"What is it, Bill, you look puzzled."

"I am, Boss. I got this old grouch that had his boiler replaced, and now he says he's always cold even with the boiler running continually. He refuses to pay the installer, and it's landed in my lap."

The Chief smiled inwardly. He was sure this problem had a solution, but he was not so sure about his budget problem with the "bean-counters." He knew they were necessary, but they didn't know "beans" about boilers. Maybe he just wasn't good at explaining; perhaps he should ask them to come out in the "field" so that he could educate them, but then deputy inspector Glutz had a National Board Commission, and he didn't have all the answers either.

"Well, Bill, tell me about it. I'd rather talk about your problem than dollars."

"Dollars?"

"Don't worry about it----proceed with your problem. Don't you know that all old people feel the cold more than you young bucks?"

"That may be true, Boss, but this old man didn't feel the cold until his old boiler was replaced with a high efficiency boiler. Now he's raving mad."

"Was there an energy analysis made of the house, and does the new boiler fall within the authorized limits?"

"That's the problem, the boiler does fall within the boundaries, but I must admit the house is cool even with the boiler going full bore."

"Okay, the first thing I want you to do is conduct an energy analysis yourself. Do a thorough job. If the boiler falls outside the low side, we might have the answer. Now get your tape measure and get going while I sit here and try to massage these budget figures."

The next morning Glutz again asked for an audience with the boss. "I'd rather massage your budget figures than try to figure out my problem."

"Well, get a cup of Joe, pull up a chair, and let's see if we can make sense out of your problem. I see you have a degree in Financial Management; perhaps after we solve your problem, you can take on mine. Now tell me about this house and heating system, and I presume your energy analysis verifies the installer's figures."

"Your right about that, Boss. The house, itself, is ancient. The old gentleman is 79 years old, and he's been living in it all his life. It's steam heating."

"Hum, all the radiators been bled; no air in them?"

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(Continued from page 3)
"Yeah, the installer did that, and I checked most of them. No air. The few traps seem to be working okay. So what now?"

" How many stories in the house?"
"Three."

"Are the risers used to heat rooms, or are they buried in the walls?"

"Oh they're buried."

"So you don't know if they are insulated?"

"No, I don't. As a matter of fact the supply and return lines in the basement aren't insulated."

"Jeez, who was the installer?"

"The Shifting sands of Texas Heating and Air Conditioning, but it's not their fault. The owner was leery of asbestos, so he told them to remove it; besides, he wanted more heat in the basement."

"Bill, you know steam is a gas that wants to give up its latent heat energy and turn back into water. It will give up that energy to anything that is colder than it is. In most heating systems the heat is at 215 degrees. So when the steam hits the cold pipe, it will condense on the pipe and so it stops moving. Insulation keeps the steam from condensing so fast. Let me get out my tables. Ah, here it is. If you had a 70 degree temperature in the basement, and a 2 1/2 inch main 50 feet long covered with insulation, the heat loss of that main would be about 2,450 Btu/h. But take off the insulation, and the heat loss would be 13,250 Btu/h. So when you remove the insulation it gives you the same effect as having an undersized boiler. When you size a steam boiler, you have to make sure its ability to produce steam matches the system's ability to condense steam. If the condenser is bigger than the evaporator, the boiler will run for a long, long time and never be able to shut off on pressure. Are you following me?"

"Yes, Boss, very much so, but I thought such variation was covered by the "pick-up" factor."

"Smart boy, now tell me what the "pick-up" factor is."

"Well, when the manufacturers rate their boilers they allow for a piping pick-up load that's equal to one third the system's radiation load."

"That's right, They figure how much radiation you'll need to heat the house, and then they add a third more boiler capacity to that to allow for the heat loss of the pipes that connect the boiler to the radiators. And this factor is for INSULATED pipes. Now in your case, the insulation has been removed from the pipes in the basement, and we don't know about the pipes in the walls. It's an old house, so it's probable that the original installers used a bigger pick-up factor, possibly one-half. Go see the old gentleman and get him to insulate the steam pipes in the basement. If that doesn't do the trick, let's get in the wall someplace and see if the risers are insulated. Can you get the data on the old boiler; that might give us the answer we need? Okay, get trucking while I juggle numbers."

"Boss, should I get him to insulate the return pipe also?"

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"Absolutely, but the reason for that is another story."

"Forgive me if I seem presumptuous, but I couldn't help notice your column of numbers. If you move your decimal points one space to the left, your figures will match."

"That shows how smart I am; I hired you. From now on be prepared to accompany me to budget meetings. And by the way, I'm much obliged."

“So am I, Boss.”

Data for this article taken from Dan Holohan's article in the February issue of Oilheating.

Operation Guidelines

(by Giovanni Ranieri)

Of switches, thermostats, clocks, and computers

Several readers called with questions and comments on the captioned subject which appeared on the last issue of the Steamer.

Some readers asked why turning the boiler off was considered operating the boiler. After all, the guy just flips a little tiny switch off, and after that the boiler is safe. What damage can be done by flipping that tiny little insignificant switch off?

Frankly, I do not have a very good answer and, other than saying that plenty of tiny little insignificant wrong switches have been flipped off and on with no insignificant consequences, my mind draws a blank.

The consequences of an operator leaving behind an “unattended” boiler are enough of a serious safety transgression for the department to be unmovable on the subject.

Other people did not like the special mention to clocks, after all a computer can be just an expensive clock. My reasoning behind it, is that for licensing matters clocks and thermostats are the building blocks. Computers employ both (and a few other tricks), but depending on the logic used, you are back to either clocks or thermostats.

Back in the old days, a thermostat ran the boiler. When the room was cold the boiler started. When the room was hot, the boiler stopped. Ah, the old days.

Then, somebody said, “there is nobody here from 9 am to 5 pm, why do we have to waste fuel?” So a timer was introduced. The room could be twenty below, but the boiler did not start until the clock said “Go”.

Computers do the same thing, but they can be programmed to do one of two things: Turn the boiler on when the thermostat calls

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for heat **AND** the clock is in the mood. **For licensing purposes** this is like having just a clock (no operator required during the off cycle of the clock).

On the other hand, computers can be programmed to turn the boiler on when the thermostat calls for heat **OR** the clock is in the mood. **For licensing purposes** this is just like having a thermostat alone (an operator must be there even if the boiler does not run). Training the operators is going to be what will make the system work, and that is going to be a responsibility of the owner.

A little test should be able to tell the operator or the inspector if you have an **AND** or an **OR** logic. If you put the boiler on demand by lowering the temperature setting and the boiler starts in spite of being outside the clock range, you have an **OR** logic and an operator is needed.

Did I confuse everybody?

Refrigeration Licensing (by Giovanni Ranieri)

I can see some faces being made "This is the Steamer, what has refrigeration got to do with it?"

Bear with me. Although I am one of those guys who is fairly comfortable pedaling backward on the cycle, most of the times I'll stick to boilers. However, I am writing this for the simple reason that a lot of you hold both steam and refrigeration licenses, and I want to alert you to a couple of potential problems.

First, to do any refrigeration work (installation, remodeling, repairs) you need an installation permit which can be obtained at DCLU's electrical permit counter. To get the permit, however, you have to enter your City of Seattle Refrigeration Contractor license number on the application. No Contractor license, no permit. This can get embarrassing if you have landed a contract and cannot perform. This is **not** a new wrinkle. Please notify your colleagues if you know of anybody doing this type of work.

The second potential problem has to do with apprentices defined in 6.82.020 of the Seattle Mechanical Code as *a person who is employed in installation, alteration, repair, servicing or operation of refrigeration systems or equipment, as an artisan, and who is registered and is working under the direct supervision of a licensed operating engineer, industrial engineer, refrigeration mechanic, or service shop mechanic.*

What is probably less known is that Chapter 6.82.050 of the Seattle Mechanical Code requires apprentices to be registered with the Board as defined in the Refrigeration License Law. All apprentices are urged to do so. We had an ammonia leak in a refrigeration plant that sent a few people to the hospital. Nothing serious, I am told, but the plant was in the care of apprentices who were not registered.

DRAFT

(by Giovanni Ranieri) Many thanks to all those who have sent material for this article. I am particularly in de in debt to Dwight Briske of Cole Industrial for the literature he sent.

For a boiler person, this word can take one of two meanings. We will talk about the less used one here today, namely the difference between atmospheric pressure and some lower pressure existing in the furnace or gas passages of a boiler.

Draft loss is the drop in **static** pressure of a gas between two points caused by friction or resistance to motion.

Natural draft, which is the focus of this discussion, is how things got started. In natural draft, the pressure differential is obtained without the use of fans from a chimney which produces static pressures which are below the atmospheric.

Stack effect is caused primarily by the difference in densities which are caused by the difference in temperatures of two vertical columns of gas. To size stacks, normally the difference in atmospheric pressure between the top and the bottom of the stack is ignored. Also ignored, is the different composition of air and combustion gasses. As it turns out, these assumptions, which are made to simplify the calculations, have little influence on the results.

Once the average temperature (the midpoint temperature) is known, the stack effect can be calculated by multiplying the difference in density by the height of the stack

Stack Effect =H*(DENSITYair - DENSITYgas).

By using the ideal gas law

Pressure=DENSITY*R*Temperature

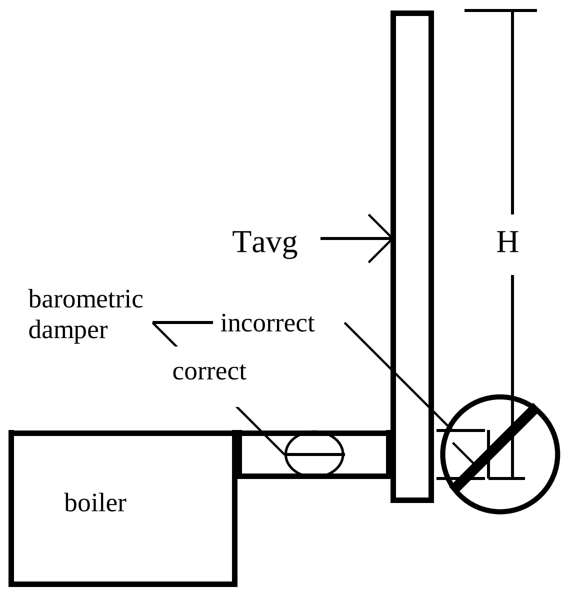
and substituting it in the equation above, we get:

Stack Effect =H*{(Pair/Rair*Tair) - (Pgas/Rgas*Tgas)}

Where R is the ideal gas constant. Since we assumed that Rair and Rgas are equal and Pair is the same as Pgas we can simplify the equation as

Stack Effect=(H*Pair/Rair)*(1/Tair-1/Tgas)

In using this equation, great care must be exercised with respect to the consistency of the units. For instance, remember that ^{o}F must be converted to ^{o}R by adding 460^{0}. The results of this equation have



been calculated for a range of temperatures and tabulated in Table 1. (see page 8)

To size the stack, one has to calculate the ideal gas velocity. However, the height of the stack is often fixed by code requirements as a function of the surrounding buildings.

The formula V = sqrt(2*g*L) is normally used to calculate velocities. L is the theoretical length of the stack which can also be expressed as the stack effect divided by the density of the flue gasses. Substituting the previous expression for the stack effect one gets:

V=sqrt (2*g*H*(Tgas/Tair - 1))

The results of this equation have been calculated in Table 2 (see page 8) for the same set of temperatures as those given in Table 1, and for a few arbitrary heights.

Table 1 Stack Effect in Inches of Water **per Each Foot** of Stack Height H

(Barometric Pressure 14.7 psi)

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Average flue temp ^{o}F	Outside Temperature ^{o}F 30	40	50	60	70	80	90
100	.0019	.0016	.0013	.0010	.0008	.0005	.0002
150	.0031	.0028	.0025	.0022	.0019	.0016	.0014
~~250~~	~~.0048~~	~~.0045~~	~~.0042~~	~~.0039~~	~~.0037~~	~~.0034~~	~~.0031~~
300	.0055	.0052	.0049	.0046	.0044	.0041	.0038
350	.0062	.0058	.0055	.0053	.0050	.0047	.0045
400	.0067	.0064	.0061	.0058	.0055	.0053	.0050

Table 2 Ideal velocity (fps) of Flue Gasses for Different Heights

Average Flue temp. ^{o}F	Outside Temperature ^{o}F 30	40	50	60	70	80	90
100	9.6	13.6	13.8	14.1	13.5	12	9.1
150	12.6	17.8	19.5	21.1	22.0	22.4	22.2
~~250~~	~~17.0~~	~~24.0~~	~~27.5~~	~~30.7~~	~~33.1~~	~~34.9~~	~~36.2~~
300	18.8	26.6	30.8	34.5	37.4	39.7	41.5
350	20.5	29.0	33.7	37.9	41.2	44.0	46.2
400	22.1	31.2	36.4	41.0	44.8	47.9	50.4
Stack heights (ft)	**10**	**20**	**30**	**40**	**50**	**60**	**70**

A few remarks are in order.

Often, the stack effect is much less than the ideal and the effect in Table 1 must be reduced by 80% or more.

The actual velocity of flue gasses is also less than the ideal (by now you have come to realize this is a hard planet). In reality, depending on the friction loss, the number of elbows, etc., the real life velocity may be 50% or even less than the ideal. That is why codes restrict the number of flow direction changes and the percentage of horizontal runs in a chimney.

To size a chimney one has to know the maximum fuel input and the amount necessary for combustion. For instance, if the maximum firing rate is 5,000,000 btuh of natural gas, the same as that given on page 11 of the January 1998 Steamer, you have 4,854 ft^3/hr of gas plus 50,045 ft^3/hr of air (for illustration purposes I assumed no excess air) or a total of 15.25 ft^3/sec.

Picking 50 ^{o}F and 250 ^{o}F as the atmospheric and average flue gas conditions, we get 0.0042*30=0.126 inches of water and 27.5 fps as the **ideal** stack effect and velocity conditions for a 30 ft stack.

Using a Flow = Velocity * Area formula, one can calculate the area as A= 15.25/27.5 =0.71 ft^2 or a chimney diameter of 10 inches.

At this moment, you may think that you are home free. Instead the fun is just beginning, since these were all ideal conditions and the effect of friction was not taken into consideration. From the diameter, velocity, and number of elbows, the designer would have to calculate the equivalent friction loss at the 30 ft height and make sure that it is not bigger than the stack effect. If it is, back to the drawing board, a larger chimney may be needed to reduce velocity and friction losses. But we stop here.

Let me make a few remarks. The first obvious one is that this is a very complex subject. Luckily, manufacturers have tabulated sizes of vents, chimneys, etc. so that you do not have to go through the calculations. However, I wanted to give you a feeling for where all these tables come from and why.

Also, I want to stress the concept of balanced draft, or the relationship between the atmospheric pressure and the pressure of the flue gases. Gasses may blow out in the boiler room through cracks

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and inspection openings at the top of the chimney even though a strong draft and a negative pressure exists at lower elevations. Correct sizing should provide a slightly negative pressure (say .1 or .2 inches of water) at the boiler flue outlet with an average temperature in the 200 to 300 ^{o}F range.

The other remark is that our designer was worried about maximum firing conditions. What happens when the boiler is idling? What happens if the height of the chimney is much higher than needed (as in a replacement situation)? Believe it or not, excess draft can disrupt combustion. Barometric dampers can aid combustion stability with varying conditions. Just in case you have not seen one, a balanced gate in these devices allows air into the chimney when pressure decreases. The result is a higher flow and lower temperature. A well designed damper will balance the draft as explained above. Double acting barometric dampers in which the gate can swing both ways to relieve momentary internal pressure, are also available.

Barometric dampers should be mounted **horizontally** as close to the boiler as possible (immediately after the flue connector is a good place), one per boiler in multiple installations. Additional or oversized dampers can be used if the chimney is too high. To avoid spillage of gasses in the room, the gate should not face the flow of flue gases (see sketch at the beginning of the article).

Sad as it is, I thought that this letter from Lew Simpson underlines the article on page 2

Dear Giovanni:

There was an old character named George Pantzer who was one of the co-owners of Hurley Engineering. George used to be the first one into Hurley's in the morning and would be out on the trouble calls getting heating plants going before others got their coffee and found their desks. He was one of those gruff characters with a heart of gold. I don't even remember which number of the pin it was, but when I first met him as a young boiler inspector, he greeted me by grilling me on the standard wiring of a Fireye controller. I probably flunked in his assessment.

Unfortunately, not too many years later, I found myself stepping over his shrouded corpse trying to ascertain exactly what went wrong and why. Evidently he had taken a trouble call on a tightly packaged cast-iron sectional boiler. This was in the early 1980's and Tacoma's Consumer Central Heating had gone out of business. Many new boiler plants were installed in Tacoma including this one.

The entire front panel of the boiler case had blown off and caught George against the concrete wall. This was a furnace explosion and yes, it is not Boiler Code jurisdiction but I thought our readers should have some appreciation of the fire side threat.

An old Birchfield or Kewanee boiler had doors on the front that would let you smell gas. This unit was a sealed package. With the old Fireye controllers with a cam, you could tell where you were. But this was some of the first electronic flame safeguards.

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A few far away readers have expressed interest in combining the articles we write with a face. Here goes the line up from left to right:
Chris Villa (territory 1), Larry Leet (territory 4), James McClinton (territory 3), George Folta (territory 2), Giovanni, and Evelyn Dunlop, Steam and Refrigeration Licensing.

Letter form Lew Simpson *(Continued from page 9)*

So what happened was the low fire limit switch in the modutrol motor failed to make at the low fire position. George had installed a jumper to start the burner and that is all it took. Probably the trouble symptom that George noticed coming into the boiler room was that the purge cycle was running continuously. As it failed, it was safe. If it was an old cam controller, his jumper probably would have worked fine. On this new model, they had wired the other side of the low fire limit as the high fire mode.

Installing the jumper made the low fire start and high fire circuit connected together. In essence, the 90 second pre-purge was a 90 second pre-fill of the boiler, breeching and stack of a gas-air combustible mixture. If the boiler front was open, George would have smelled it, but sealed with no door, there was no clue. The good news was he had no idea the explosion was coming and didn't suffer. The bad news is we lost a good friend and the best expert on a rotary cup burner that I ever knew.

Maybe this is a little long winded. For those just starting out, the modutrol motor is the thing that drives the gas valve and air damper controlling the firing rate. What could have George done differently? Turn off the gas before starting to troubleshoot.
Lew Simpson

Lew

The *Steamer* is generally published quarterly by the City of Seattle, Department of Construction & Land Use, Boiler Pressure Systems Inspection Section. The intent of the publication is to provide information to interested persons in related fields. Readers are welcome to submit material for publication (subject to approval). Any materials submitted for publication will become the property of the Department unless prior arrangements are made. Readers are welcome to reprint any original material (the copyrights of others must be respected); we ask only that you credit the *Steamer* as the source.

Washington State Boiler Inspectors' Association

Monthly Meetings are held on the first *working* Monday of each month at Andy's Diner, 2963 - 4th Ave S., approximately two blocks north of Spokane Street. From I-5, take the Spokane Street exit, stay to your right, take the 4th Ave S. exit, then north a few blocks to the restaurant which will be on your left. Lunch is at noon and the meeting is called to order at 12:30 PM.

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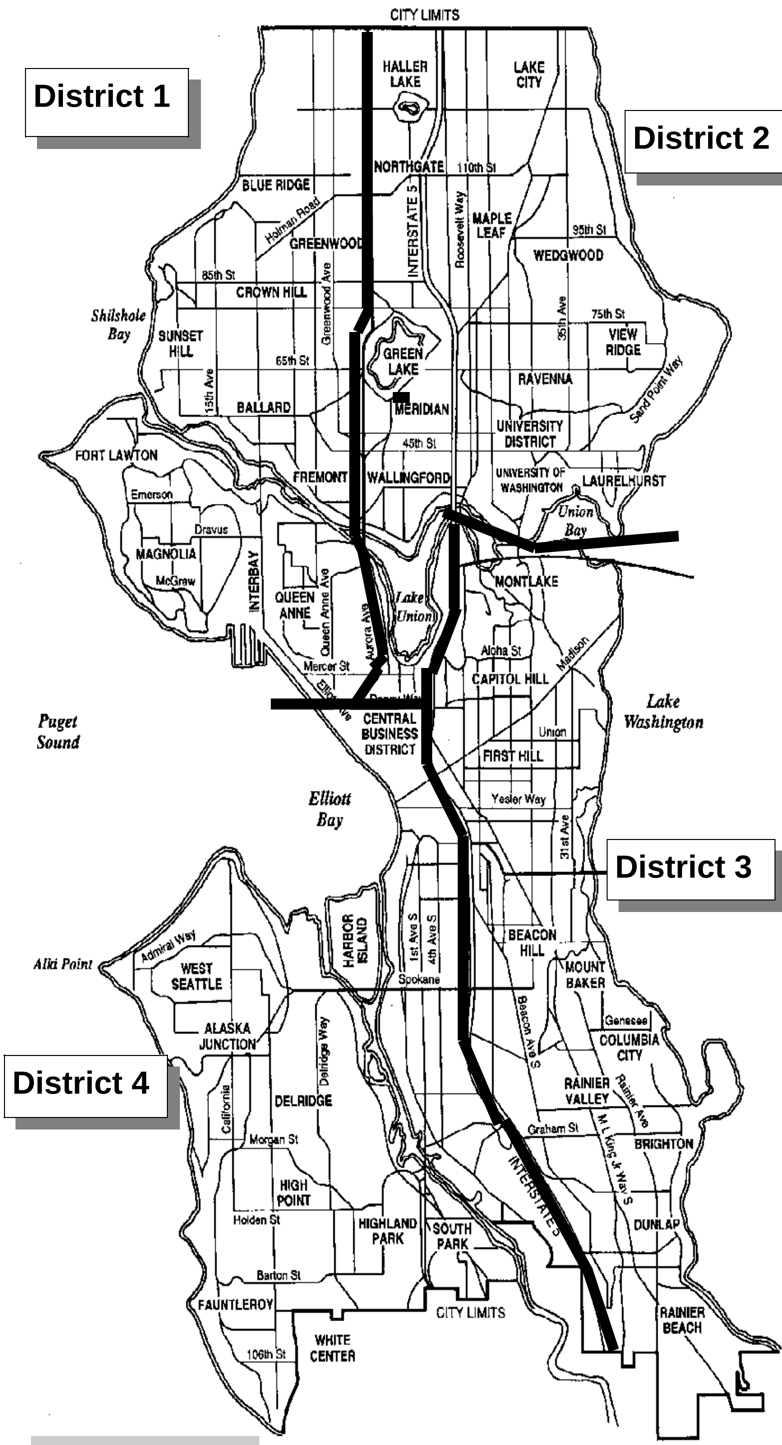

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